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DESIGN ESTIMATION OF BRUSHLESS SEDC MOTOR FOR SPEED CONTROL BY USING VARIOUS CONTROLLERS

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ABSTRACT

The BLSEDC motors have many applications due to their use in modern life because of the simplest construction, simple maintenance, low price and reliability. The importance of brushless SEDC electric motors in the continuous growing automotive industry. The working force behind market growth is 'motorists' insatiable demand for safety, comfort, economy, a clean environment and overall quality of driving. This paper presents design estimation of brushless SEDC motor by proportional as well as fuzzy rule using MATLab/Simulink. This Fuzzy rule method is feasible due to the unique and simplified structure of this motor.

KEYWORDS: Brushless SEDC Motor, PID Controller, Fuzzy Controller

INTRODUCTION

The new design concept of permanent magnet brushless motors has already been developed [1 2]. The permanent magnet brushless motor can be classified into the back-EMF waveform, where it can be operated in either brushless AC (BLAC) or brushless DC (BLDC) modes[3 4]. Usually the BLAC motors have a sinusoidal back-EMF waveform and BLDC motors have a trapezoidal back-EMF. In modern electrical machines industry productions of the brushless separately excited direct current (BLSEDC) motors are rapidly gaining popularity [5 6]. BLSEDC motors are used in industries such as Appliances medical, road vehicles, aircrafts, military equipment, hard disk drive, electric traction etc. Comparing BLSEDC motors with DC motors, the SEDC motor have high starting torque capability, smooth speed control and the ability to control their torque and flux easily and independently [7 8]. In the DC motor, the power losses occur mainly in the rotor which limits the heat transfer and consequently the armature winding current density, while in BLSEDC motor the power losses are practically all in the stator where heat can be easily transferred through the frame, or cooling systems can be used specially in large machines. In general the BLSEDC motor has many advantages like as: their simplest construction, simple maintenance, low price and reliability [9 10]. More advantages of the BLSEDC motor, more efficient to use and become more attractive option than other motors.

MODEL OF THE BLSEDC MOTOR

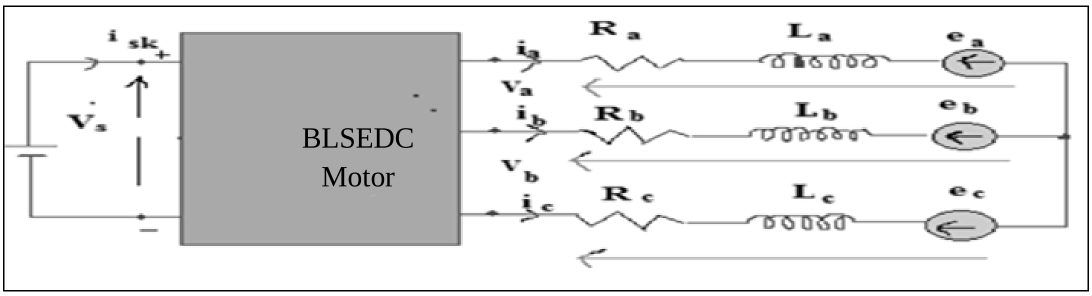

Figure 1: Electrical Model of the BLSEDC Motor

Here we assume for a symmetrical winding and balanced system, the voltage equation across the motor winding is as follows:

Applying Kirchhoff's voltage law for the three phase stator loop winding circuits yields

$$V_a = R_a i_a + L_a \frac{di_a}{dt} + M_{ab}\frac{di_b}{dt} + M_{ac}\frac{di_c}{dt} + e_a \quad (1)$$

$$V_b = R_b i_b + L_b \frac{di_b}{dt} + M_{ba}\frac{di_a}{dt} + M_{bc}\frac{di_c}{dt} + e_b \quad (2)$$

$$V_c = R_c i_c + L_c \frac{di_c}{dt} + M_{ca}\frac{di_a}{dt} + M_{cb}\frac{di_b}{dt} + e_c \quad (3)$$

Here the back-EMF waveforms e_a , e_b and e_c are functions of angular velocity of the rotor shaft, so The electromechanical torque is expressed as

$$T_{em} = J\frac{d\omega_r}{dt} + B\omega_r + T_L \quad (4)$$

But the electromagnetic torque for this 3-phase BLSEDC motor is dependent on the current, speed and back-EMF waveforms, so the instantaneous electromagnetic torque can be represented as:

$$T_{em} = \frac{1}{\omega_m}(e_a i_a + e_b i_b + e_c i_c) \quad (5)$$

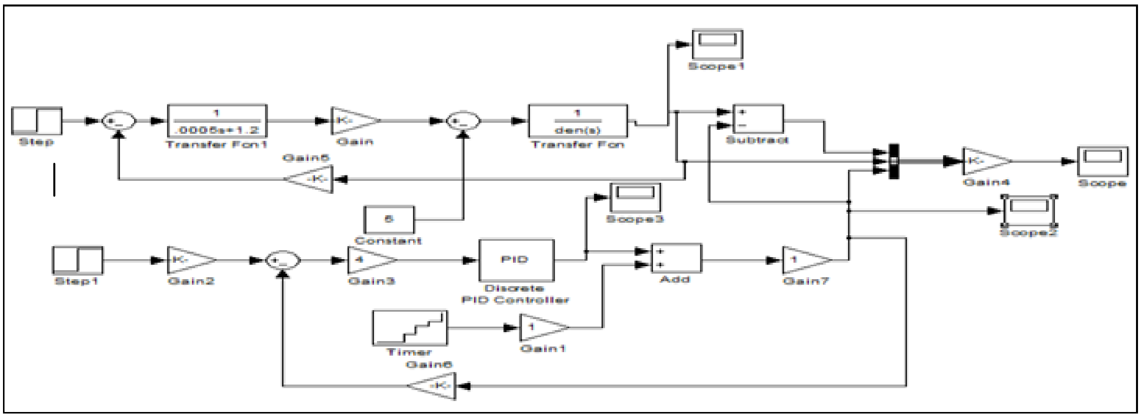

Figure 2: Simulink Model of BLSEDC Motor Using P Controller

The simulation of the BLSEDC motor was done using the software package MATLAB/SIMULINK. After running the simulation, the speed, torque, current, waveforms were recorded and analyzed. Figure 3 shows the open loop response of the motor.

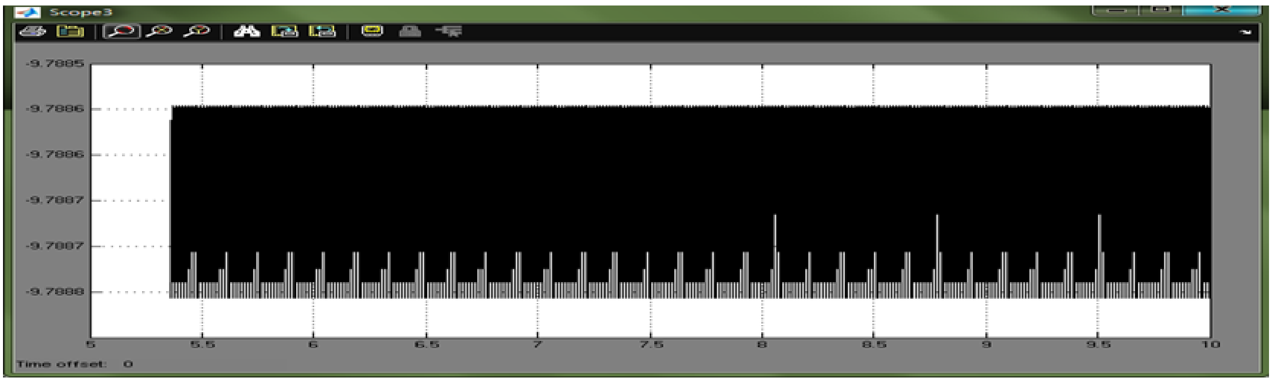

Figure 3: Open Loop Speed Response of the Motor

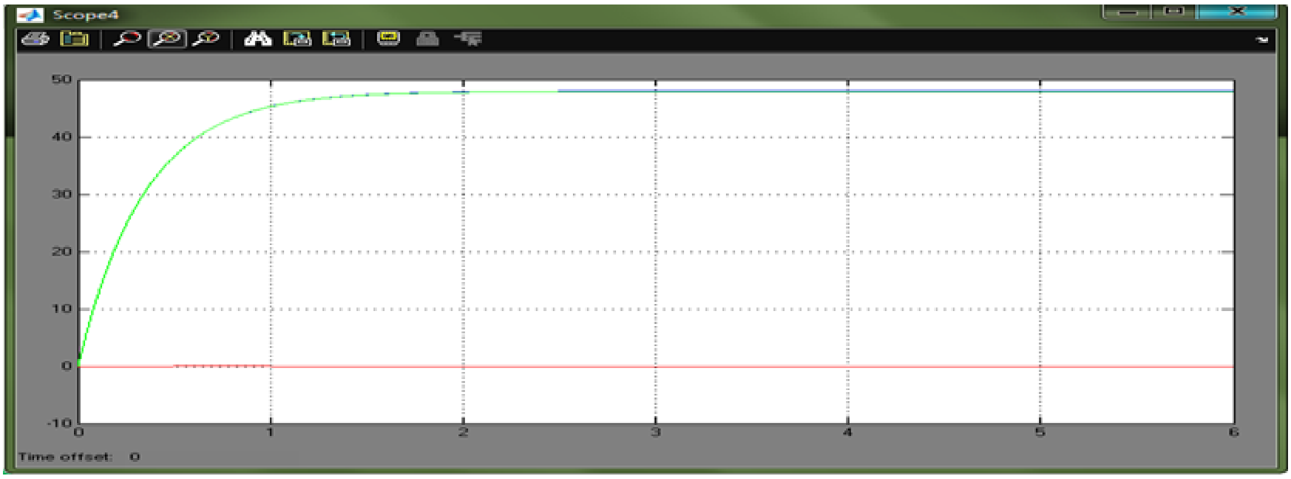

Figure 4: Speed Response with Using P Controller

A simulation of a brushless SEDC motor system with the PID gains has been performed using MATLAB. The gains of PID control are provided in Table 1. The speed response is shown in Figure 4. So it can be concluded that a direct P tuning method is suitable to designate self-tuning technique for BLSEDC motor, where the overshoot in the motor speed response approximately zero and the error steady state is also go to zero.

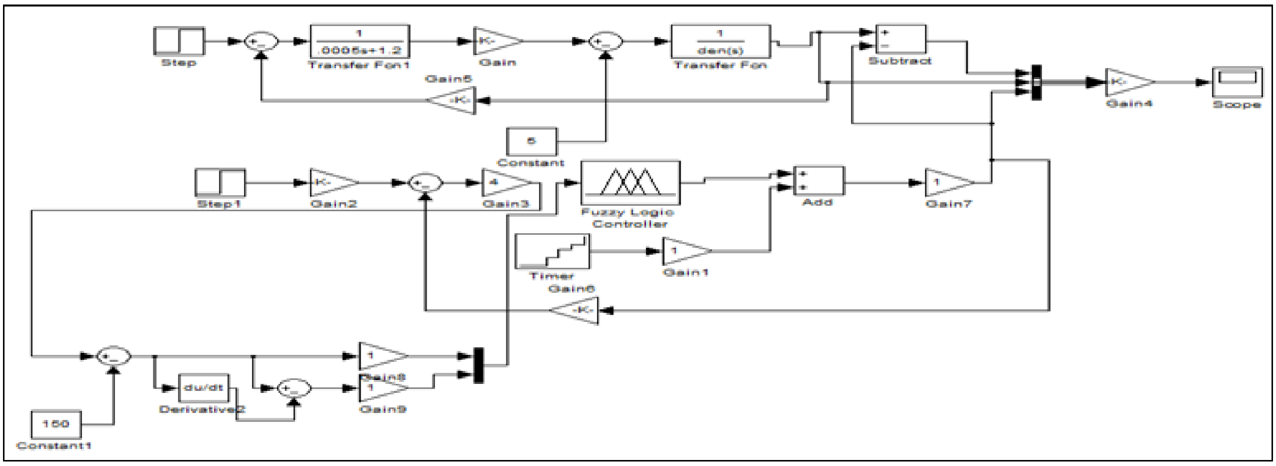

Figure 5: Simulink Model of BLSEDC Motor Using Fuzzy Controller

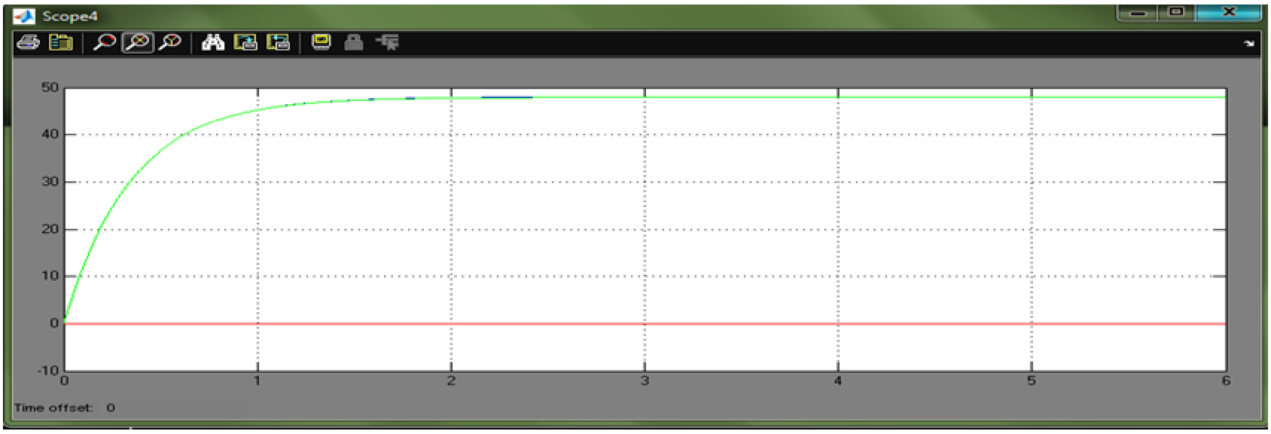

Figure 6: Speed Response with Using Fuzzy Controller

Table 1: PID Parameters

S.No.	Constant of PID Gains	Values
1	K_p	1
2	K_i	0
3	K_d	0

CONCLUSIONS

In this paper, a mathematical model of brushless SEDC motor is developed. The simulation of the brushless SEDC motor has been done using the software package MATLAB/SIMULINK. Simulation of brushless SEDC motor PID control based is presented. This method is feasible due to the unique and simplified structure of this motor. The PID controller designed has been simulated and observed, the results shows that the overshoot before adding the P control was 71% but after adding P controller the maximum overshoot is approximately zero which shows a better response. After applied Fuzzy Controller for closed loop operation of the BLSEDC motor runs very closed to the reference speed.

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